


IMAGING MODALITIES RELEVANT TO INTRACRANIAL PRESSURE ASSESSMENT IN ASTRONAUTS

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Disclosure Information

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Ashot E. Sargsyan


I have no financial relationships to disclose.

I will not discuss off-label use and/or investigational use in my presentation






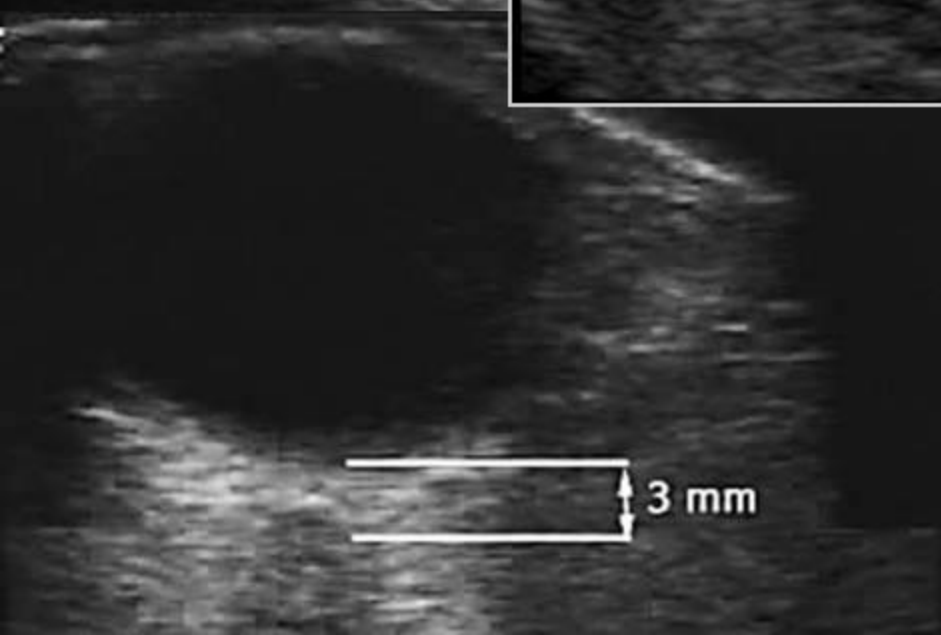
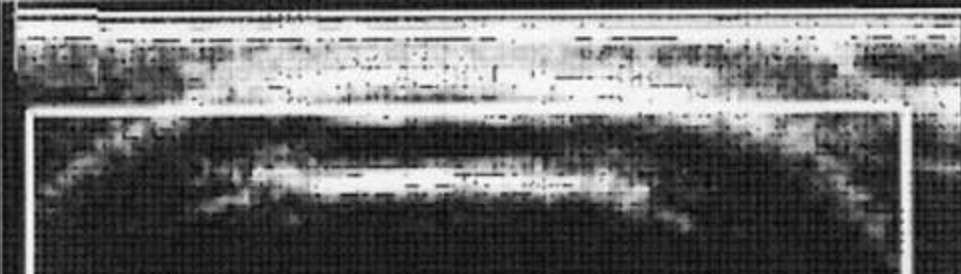
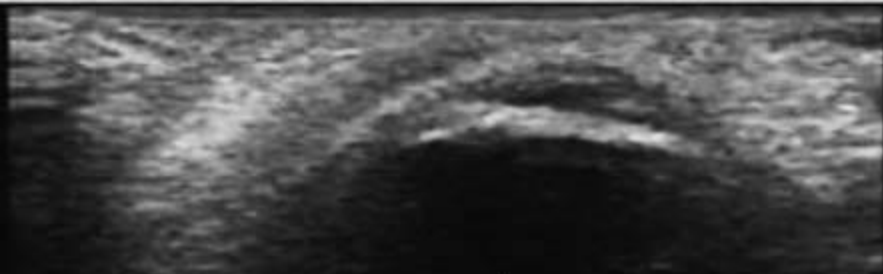
Learning Objectives

- 1: To review the morphological changes in orbit structures caused by elevated ICP, and their imaging representation.
 - 2: To learn about the similarities and differences between MRI and sonographic imaging of the eye and orbit.
 - 3: To learn about the role of MRI and sonography in the noninvasive assessment of intracranial pressure in aerospace medicine, and the added benefits from their combined interpretation.
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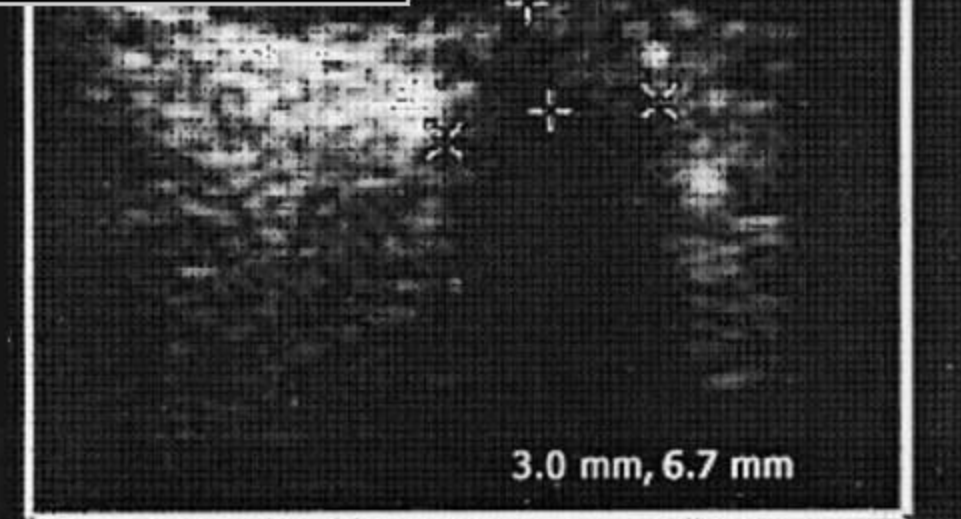


Introduction

- Intracranial pressure (ICP) elevation has been inferred or documented in a number of space crewmembers.
 - Recent advances in noninvasive imaging technology offer new possibilities for ICP assessment.
 - No standards or applicable evidence-based guidelines/criteria are available for immediate use.
 - NASA and its ISS partners adopted a battery of occupational health monitoring tests including:
 - Magnetic resonance imaging (MRI) pre- and postflight;
 - High-definition sonography of the orbital structures in all mission phases including during flight.
 - We hypothesize that joint consideration of data from the two techniques has the potential to improve quality and continuity of crewmember monitoring and care.
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3 mm



3.0 mm, 6.7 mm

Macroscopic Anatomical Substrate

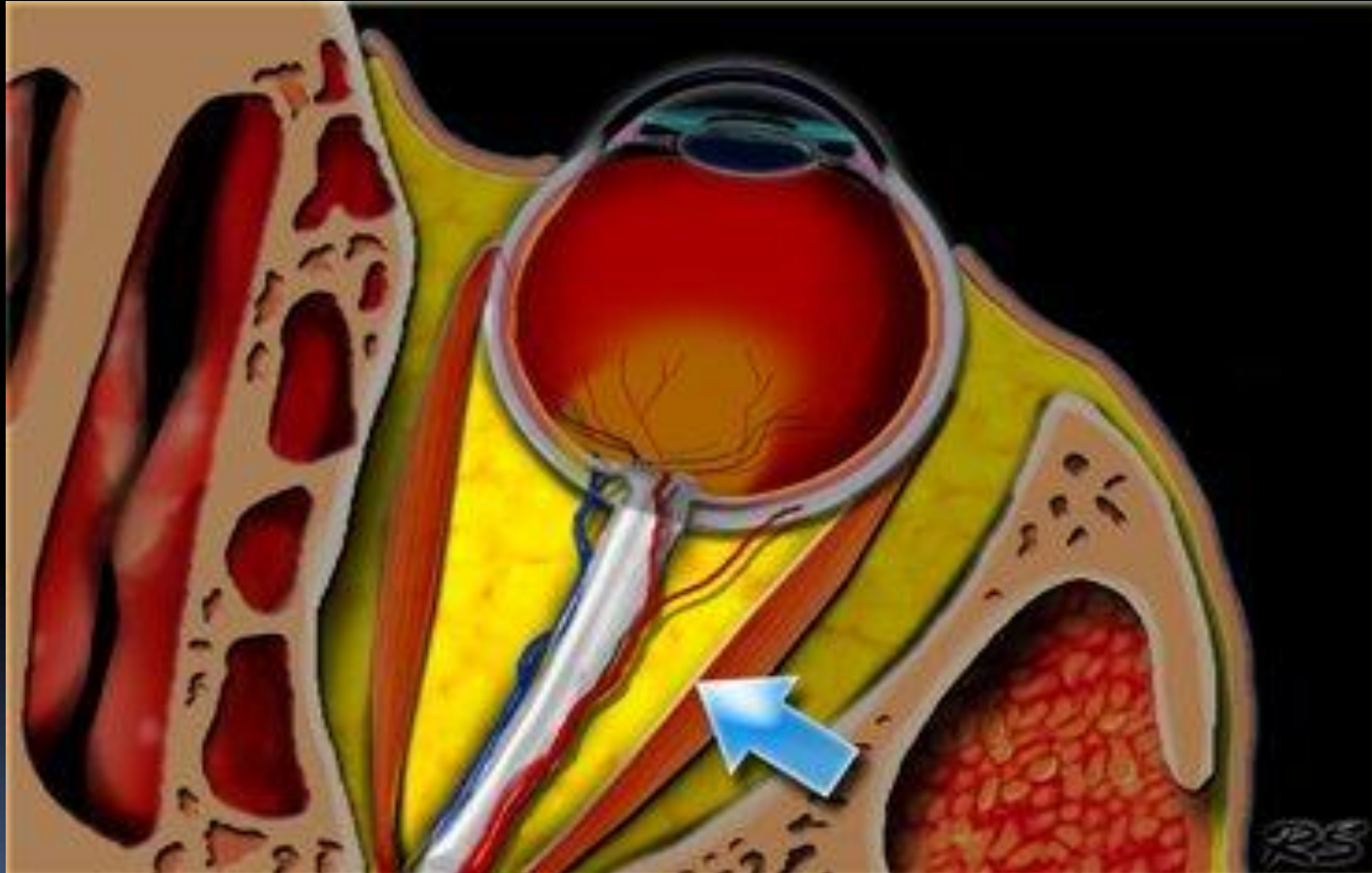
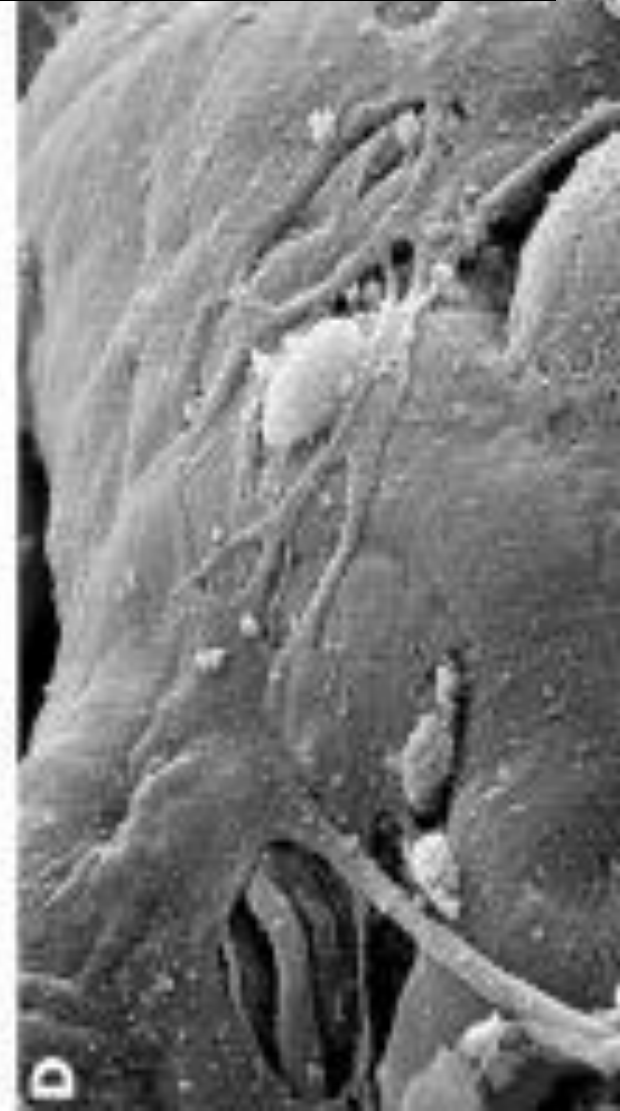
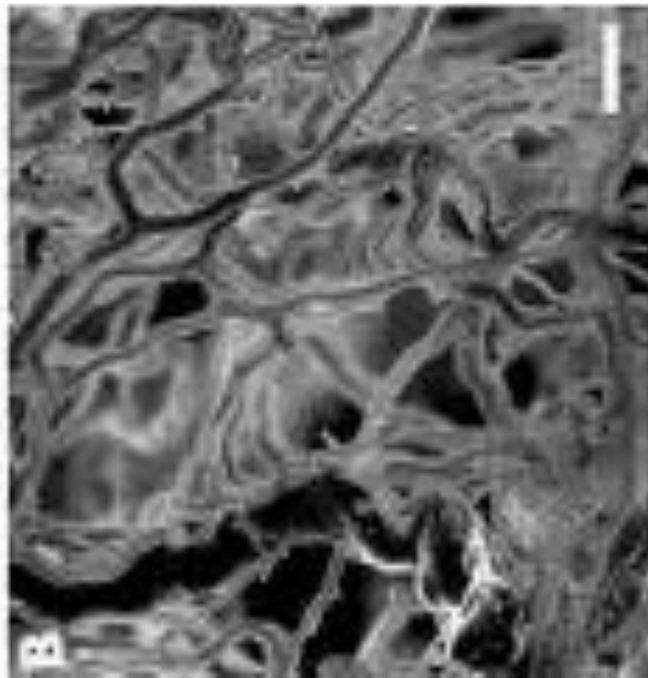
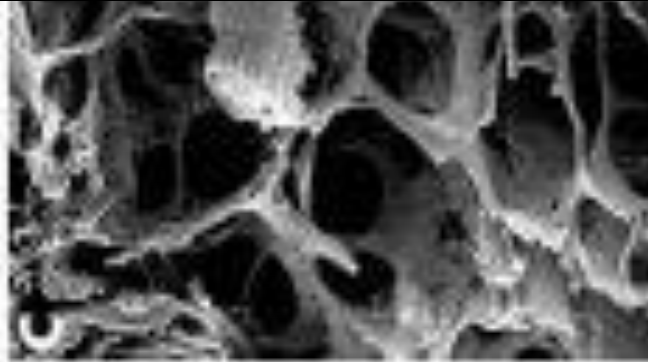
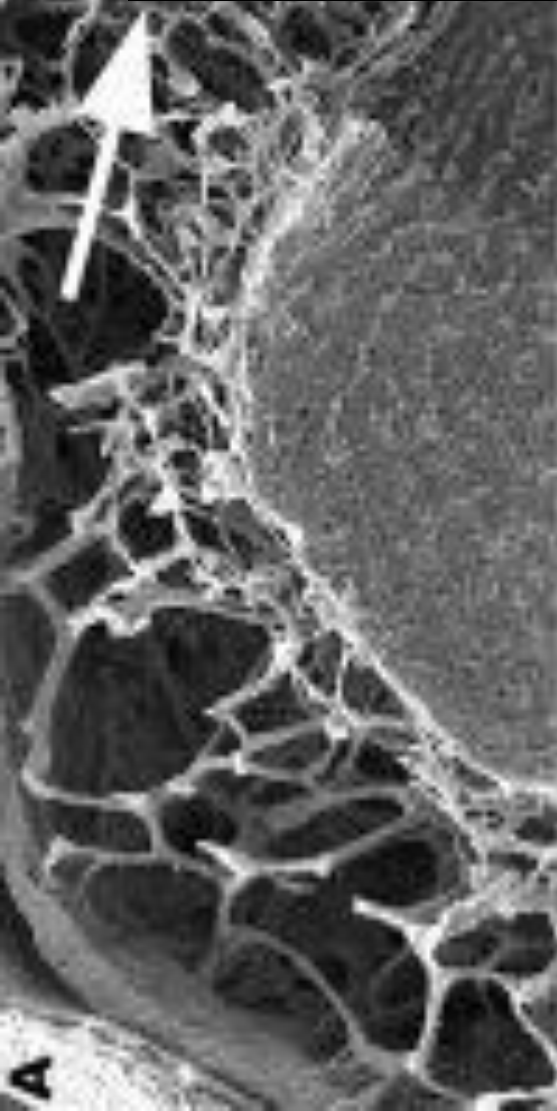



Image Source: Orbital Pathology *by David Youssef*
Neuroradiology department of the Johns Hopkins Hospital in Baltimore
<http://www.radiologyassistant.nl>

Microscopic Anatomical Substrate





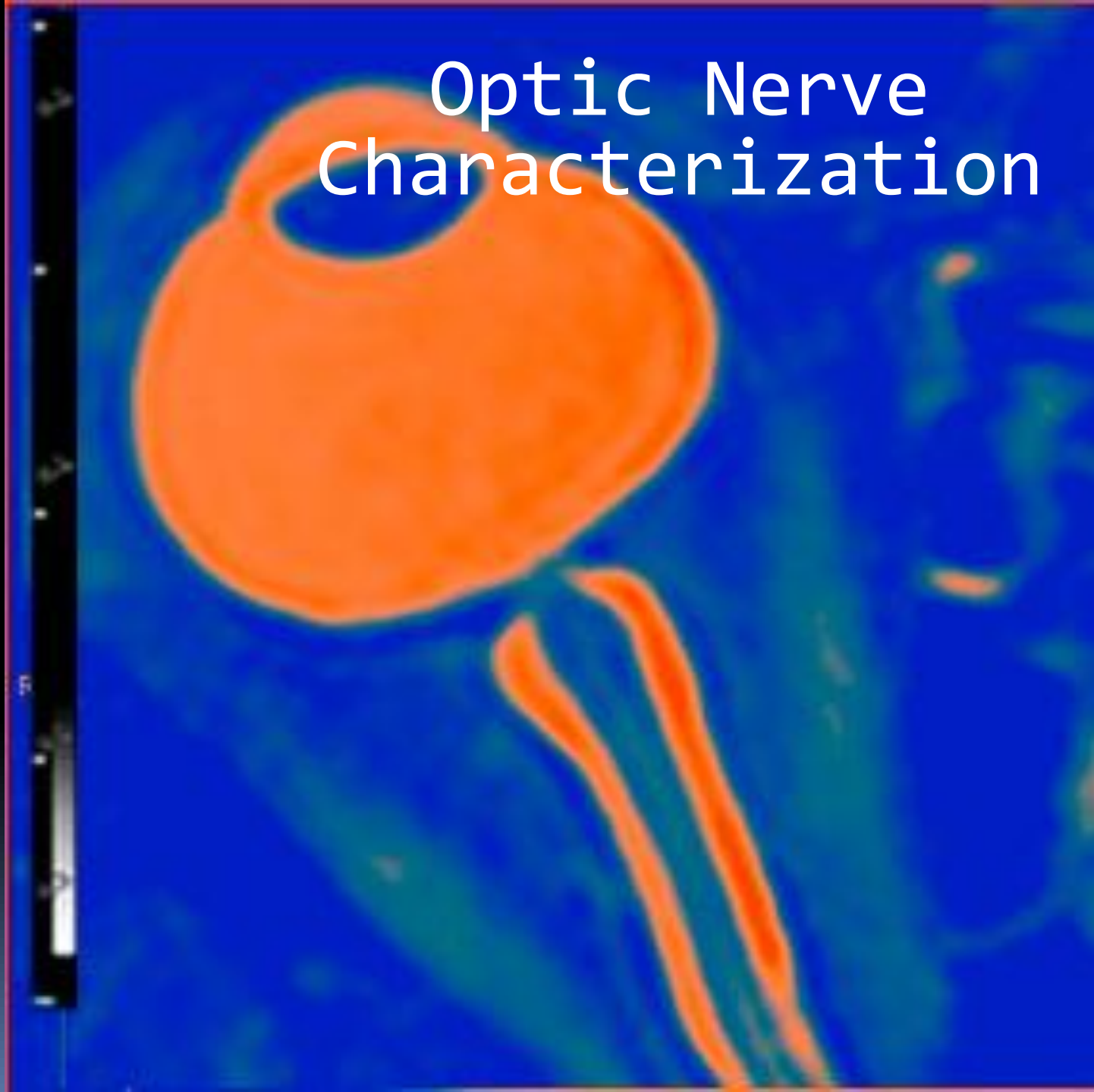
Methods

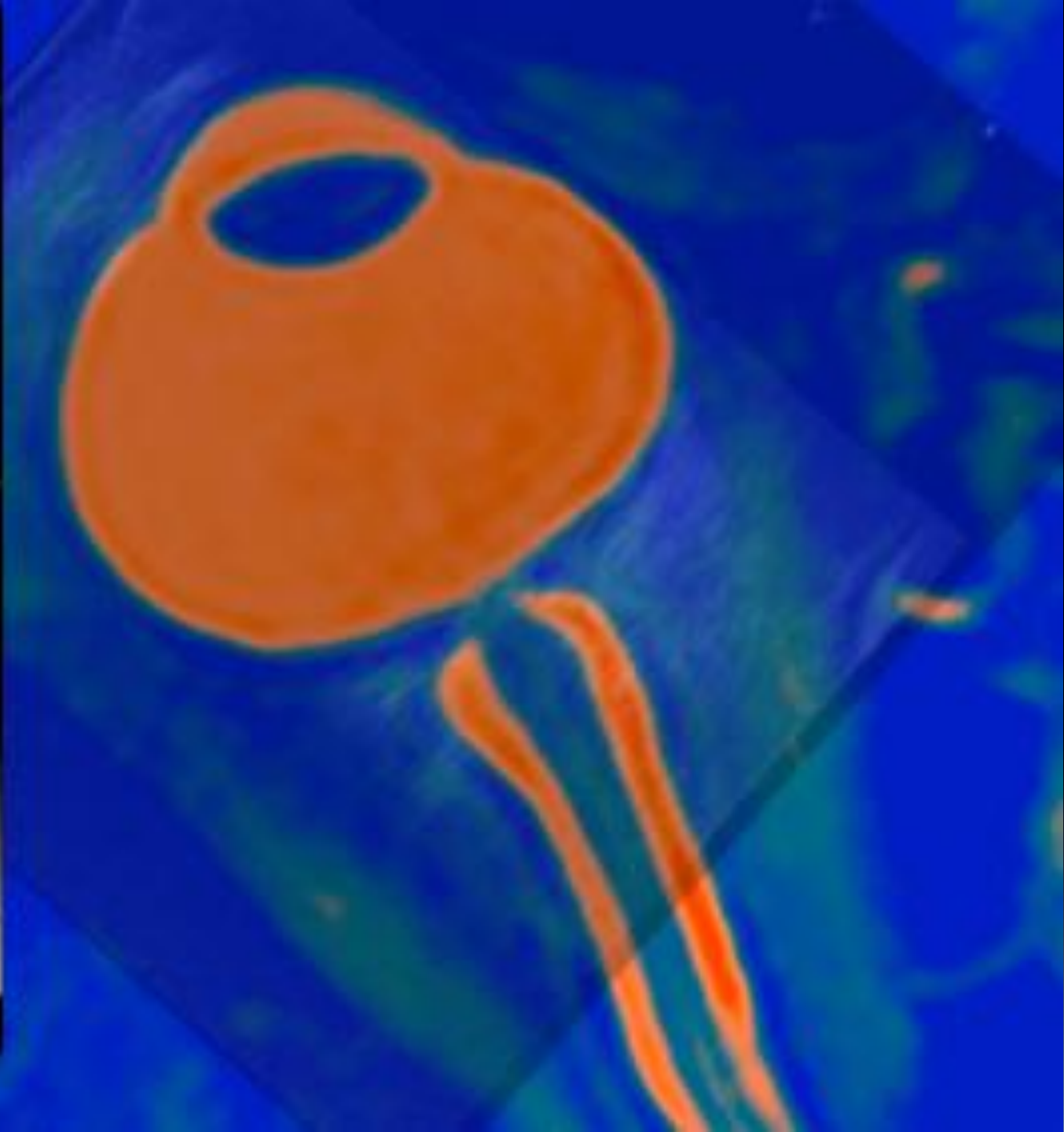
- Identification of redundant parameters in MR and sonographic data sets
 - Comparisons of MR and sonographic measurements of the optic nerve and optic nerve sheath
 - Comparison of posterior globe curvature measurements from MR and sonographic images
 - Assessment of the potential of image “fusion” between MR and sonography
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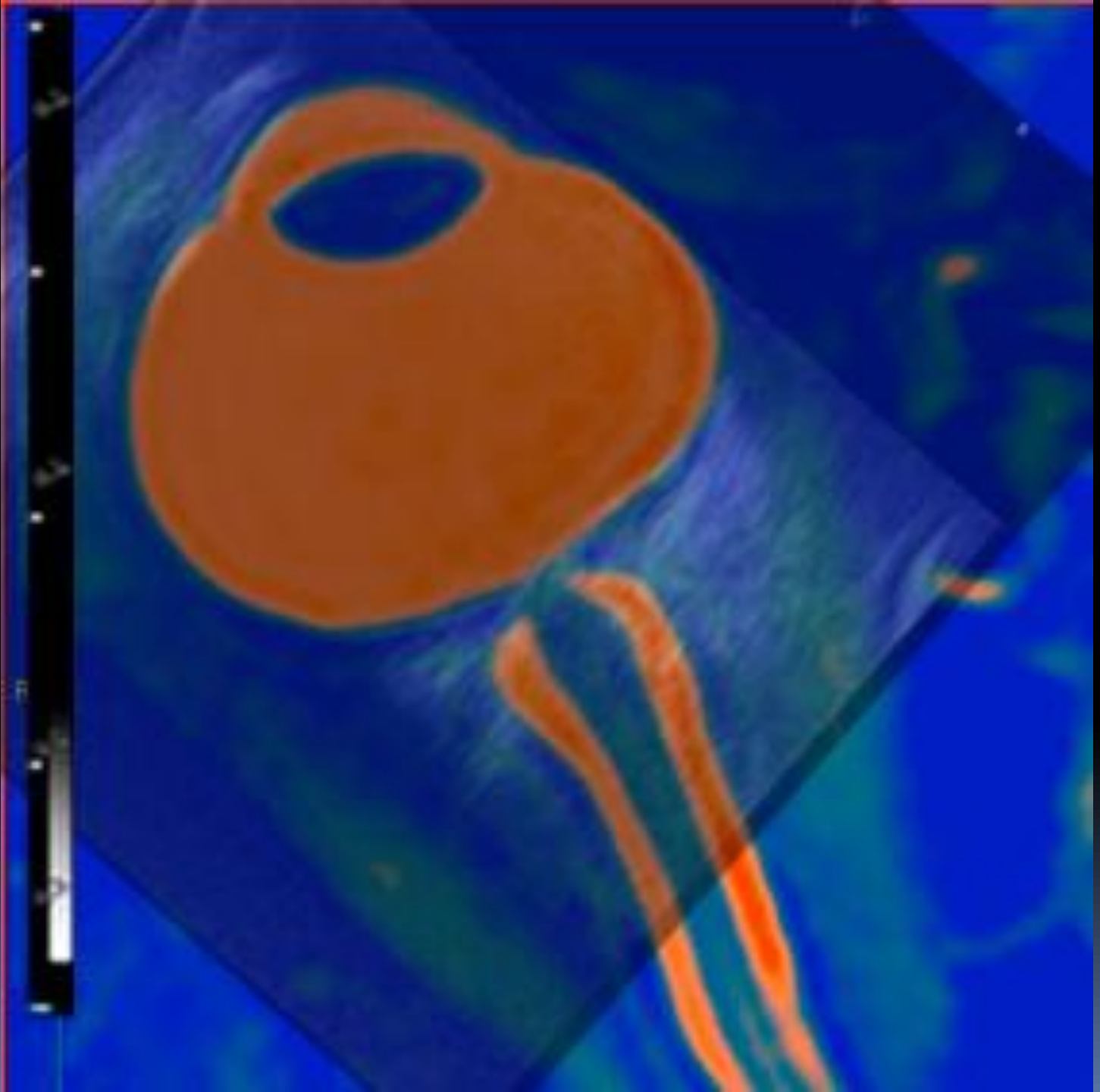
Methods

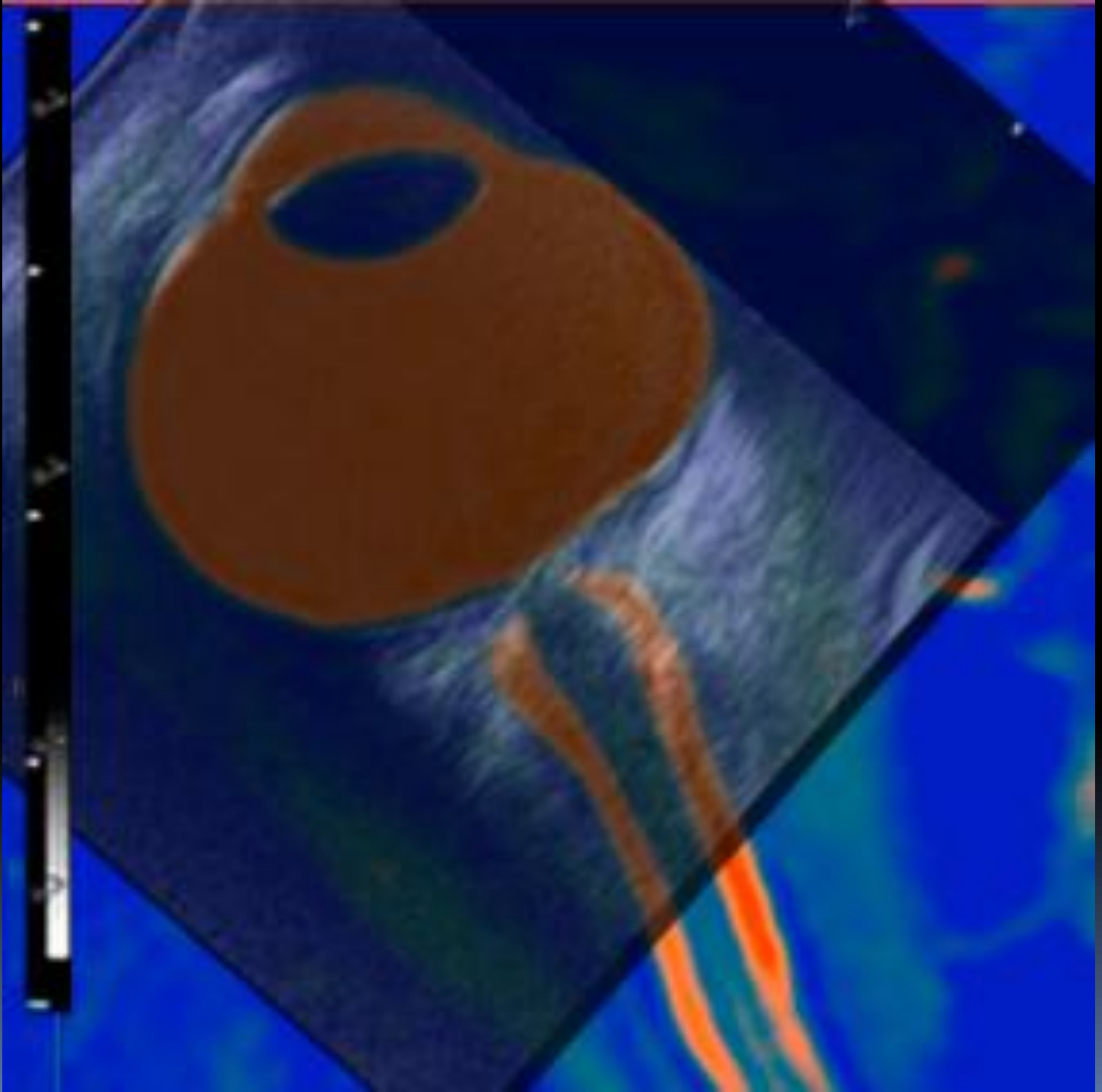
PARAMETER	US	MRI	FORMAT
Anterior chamber survey	X		free text based on entire image set
Posterior chamber survey	X		free text based on entire image set
Antero-posterior Diameter	X		numerical
Papilledema/Disc Edema	X	X	semi-quantitative: 0-3
Globe flattening	X	X	semi-quantitative: 0-3
Optic Nerve Sheath Diameter	X	X	within 3-5 mm from retina; numerical
Characterization of optic nerve sheath structure	X		free text based on entire image set
Optic Nerve Diameter	X	X	within 3-5 mm from retina; numerical
Optic Sheath-Nerve Ratio	X	X	calculated, numerical, unitless
ON tortuosity	X	X	semi-quantitative: 0-3
ON sheath hypoechogenicity	X		
ON T2-hyperintensity		X	semi-quantitative: 0-3
Survey of intracranial CSF spaces		X	free text based on entire image set
Characterization of sella turcica and pituitary		X	free text based on entire image set
Assessment of CSF production rate		X	numerical
Characterization of CSF flow through the Sylvian aqueduct		X	numerical
Other Notes: Compared with: [dates] IMPRESSION:	x	x	free text

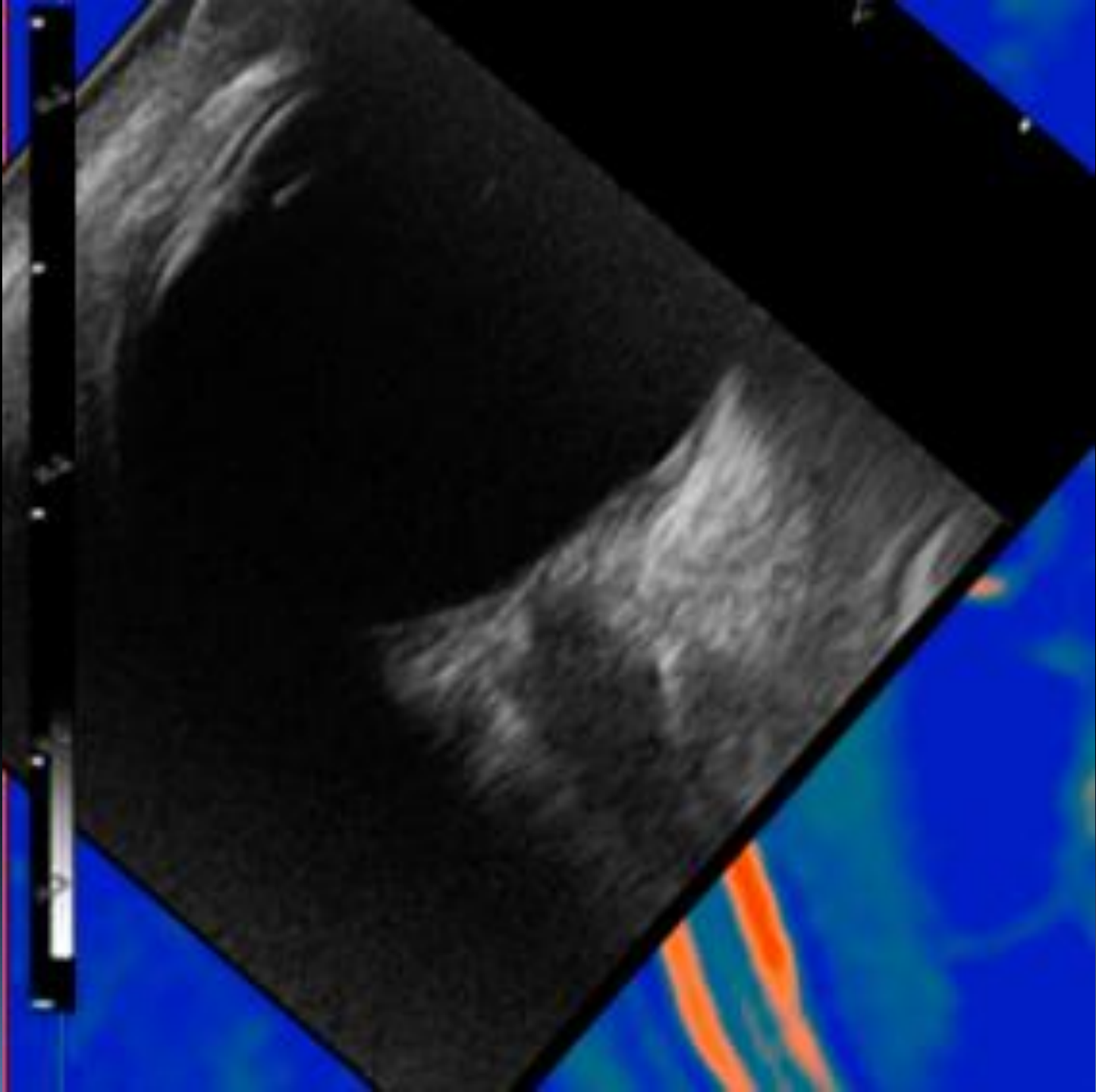
Optic Nerve Characterization

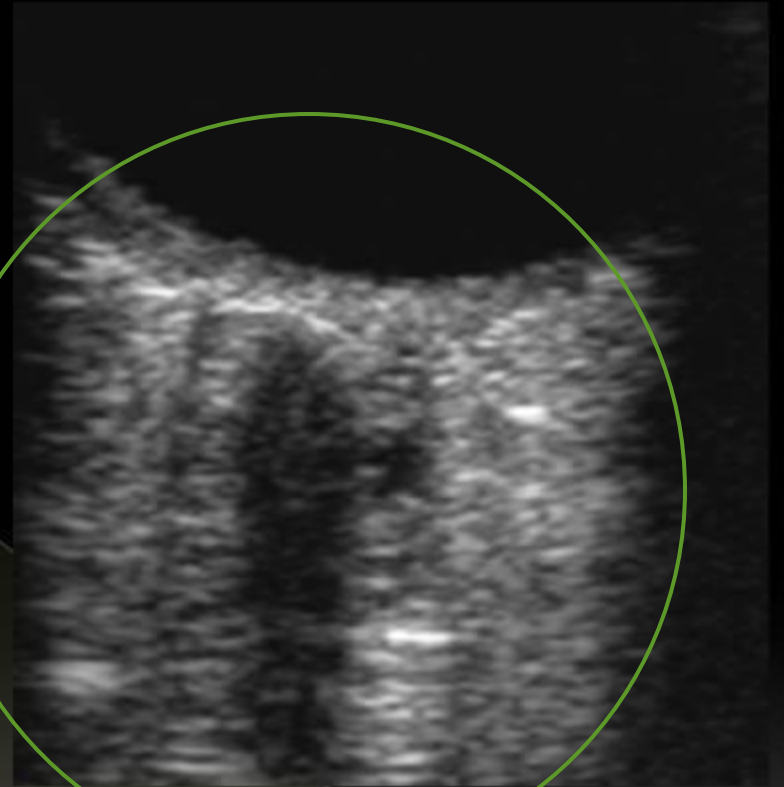
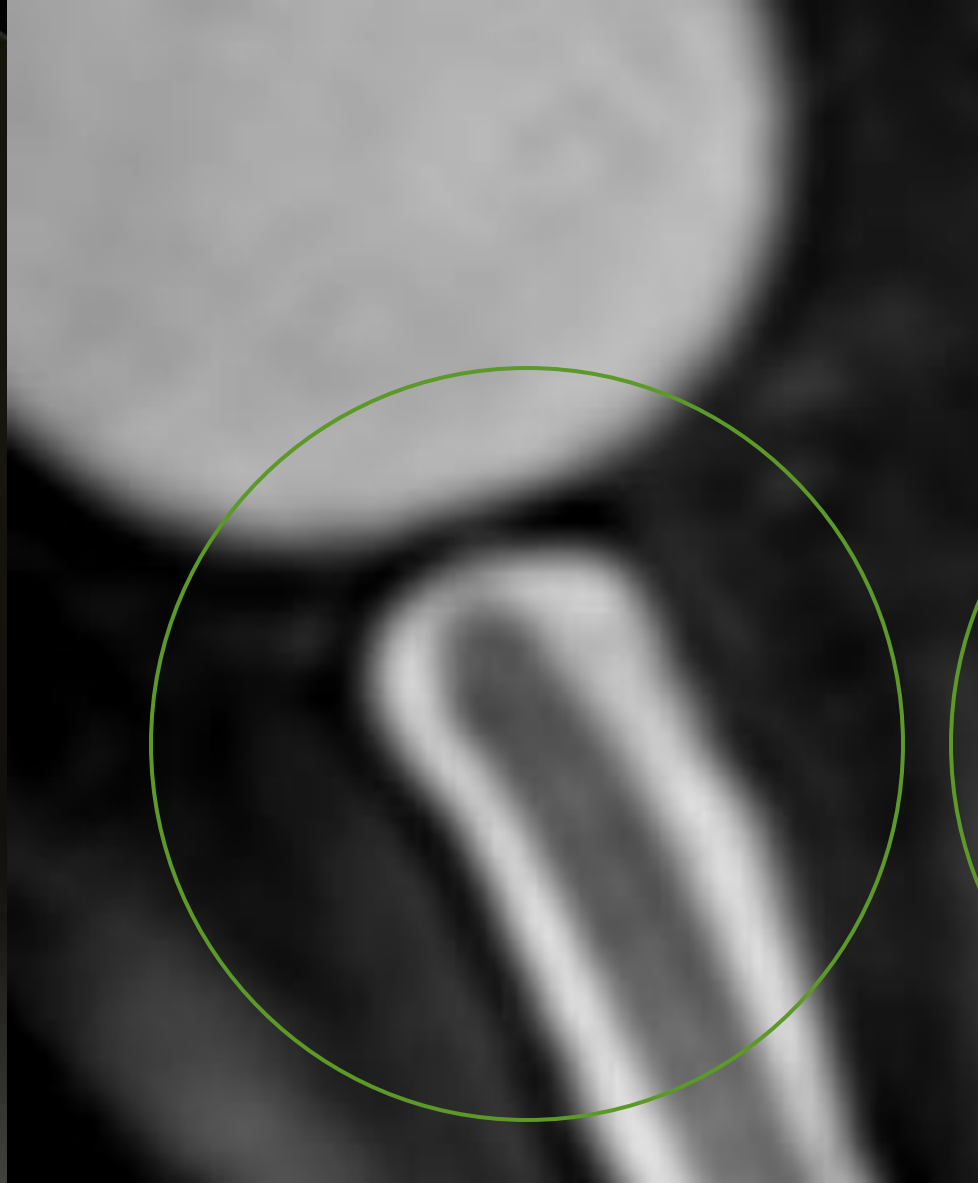




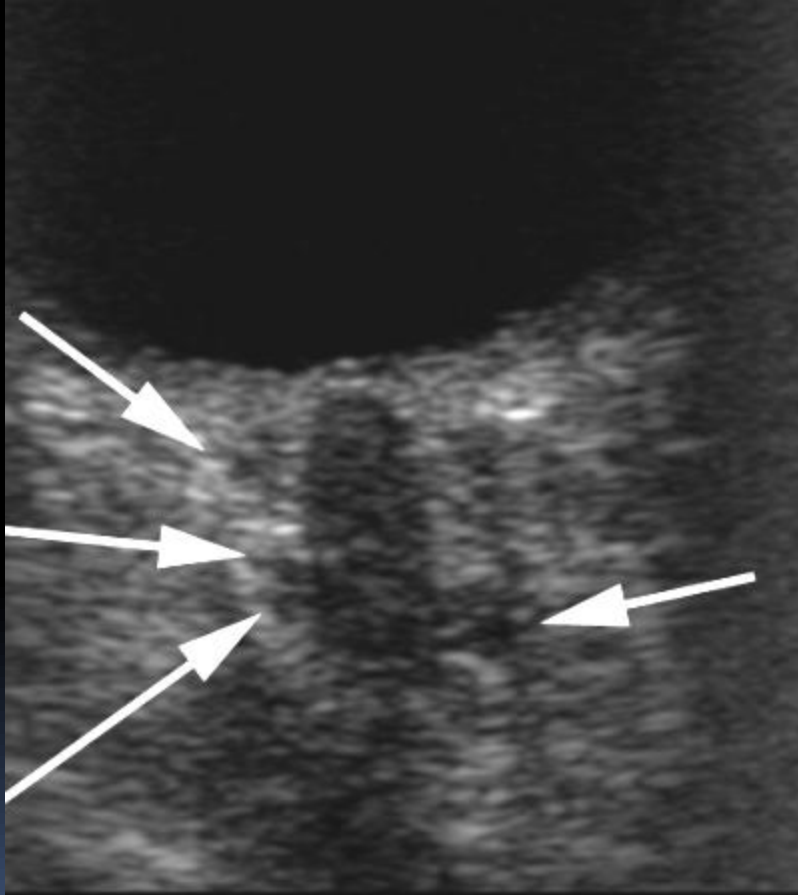




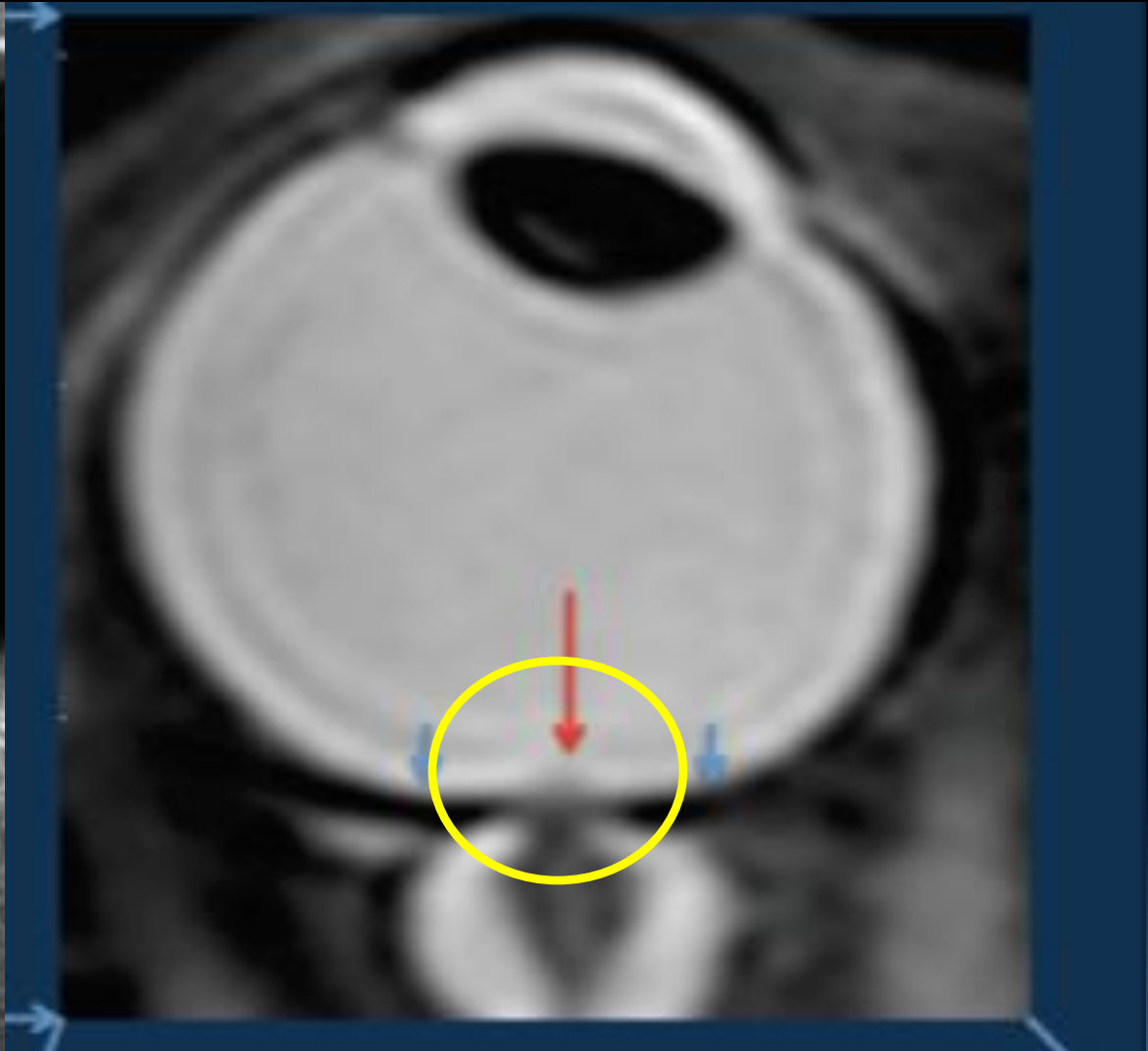
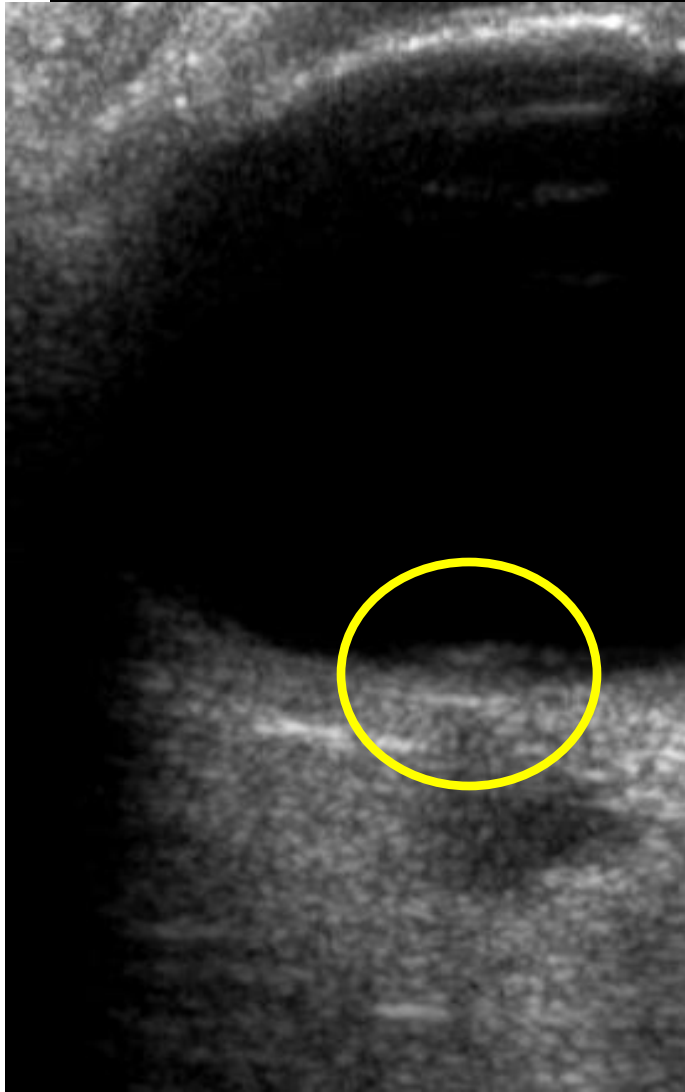




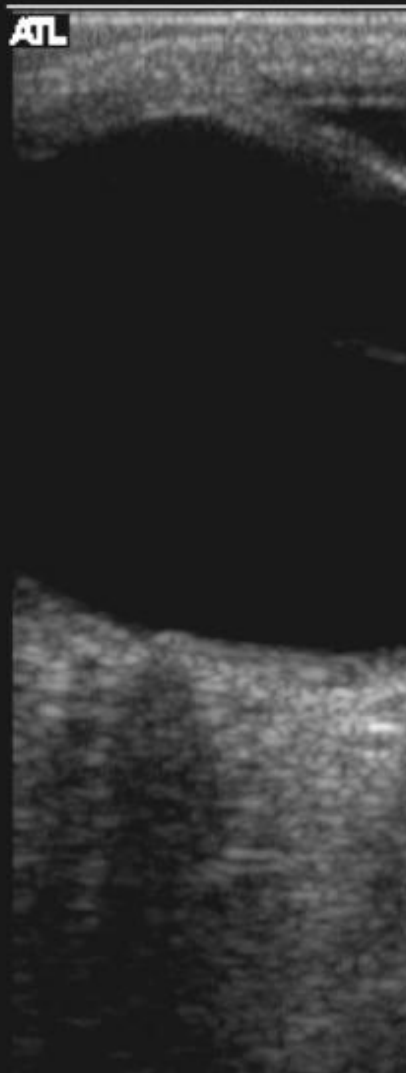
ONS Structure

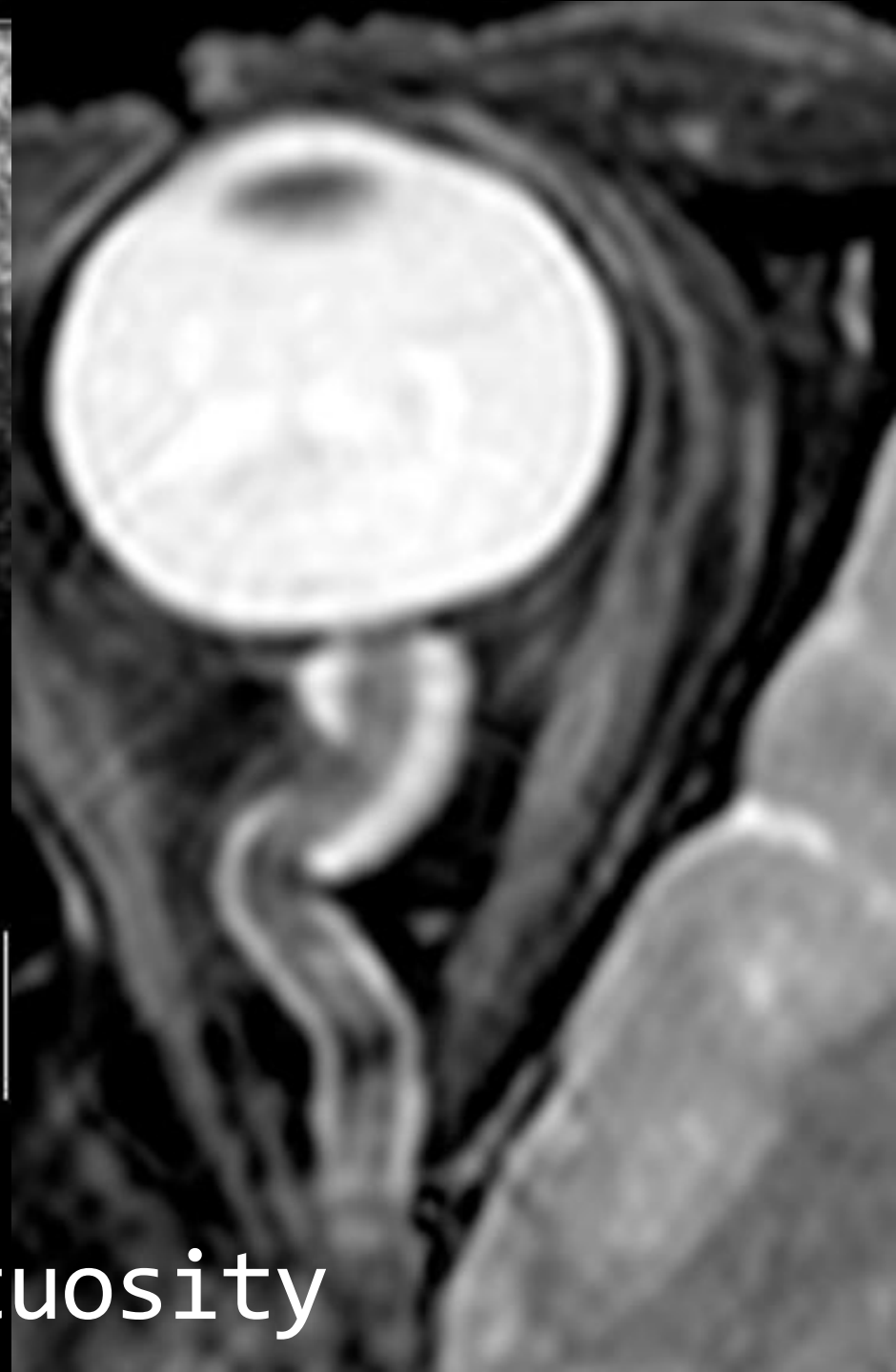


Papilledema



Map 3
150dB/C5
Persist Med
Fr Rate High
2D Opt:Res





ON/ONS Tortuosity

ATL

Preflight



ATL

Preflight

Postflight



ATL

Preflight

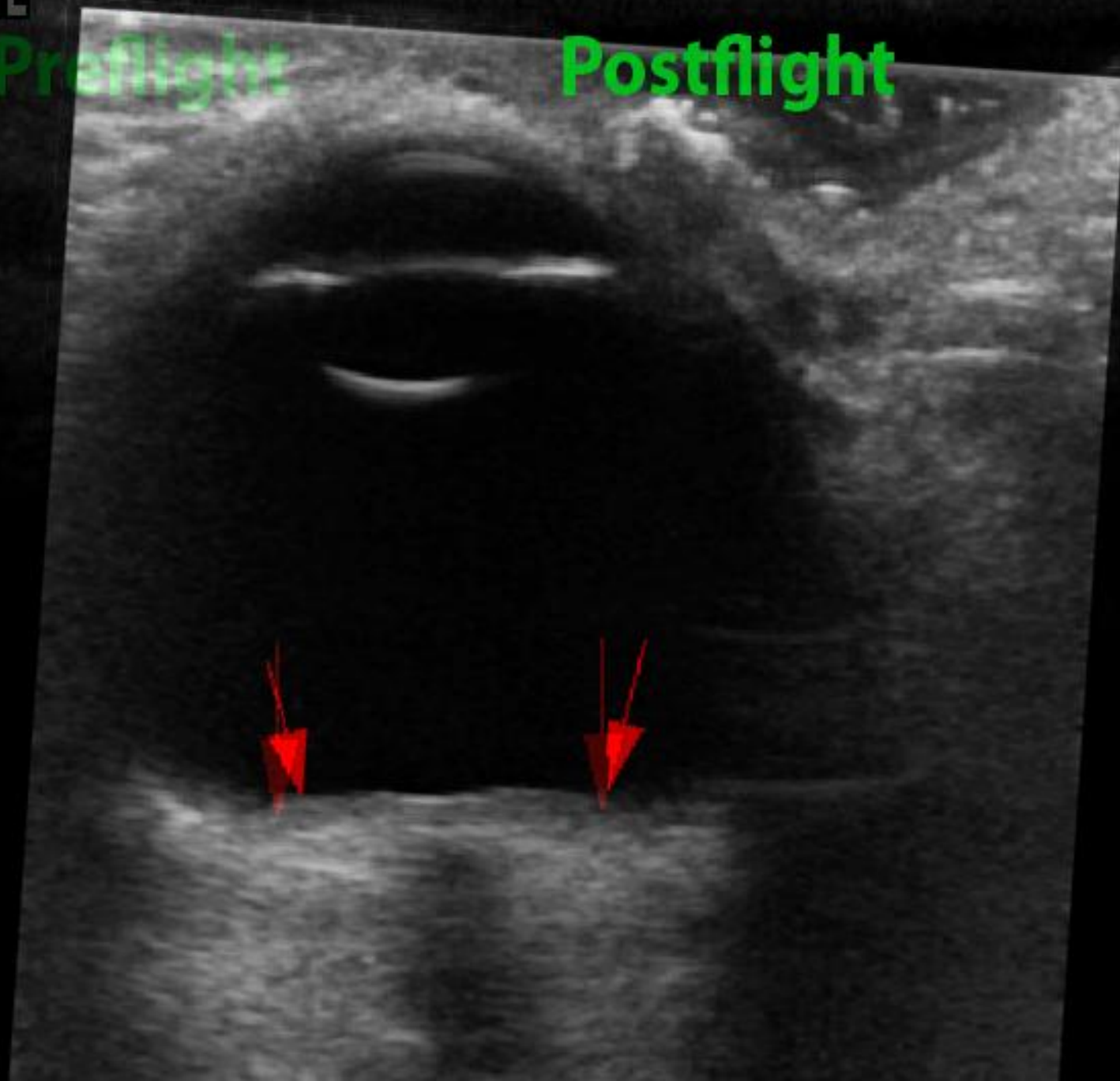
Postflight



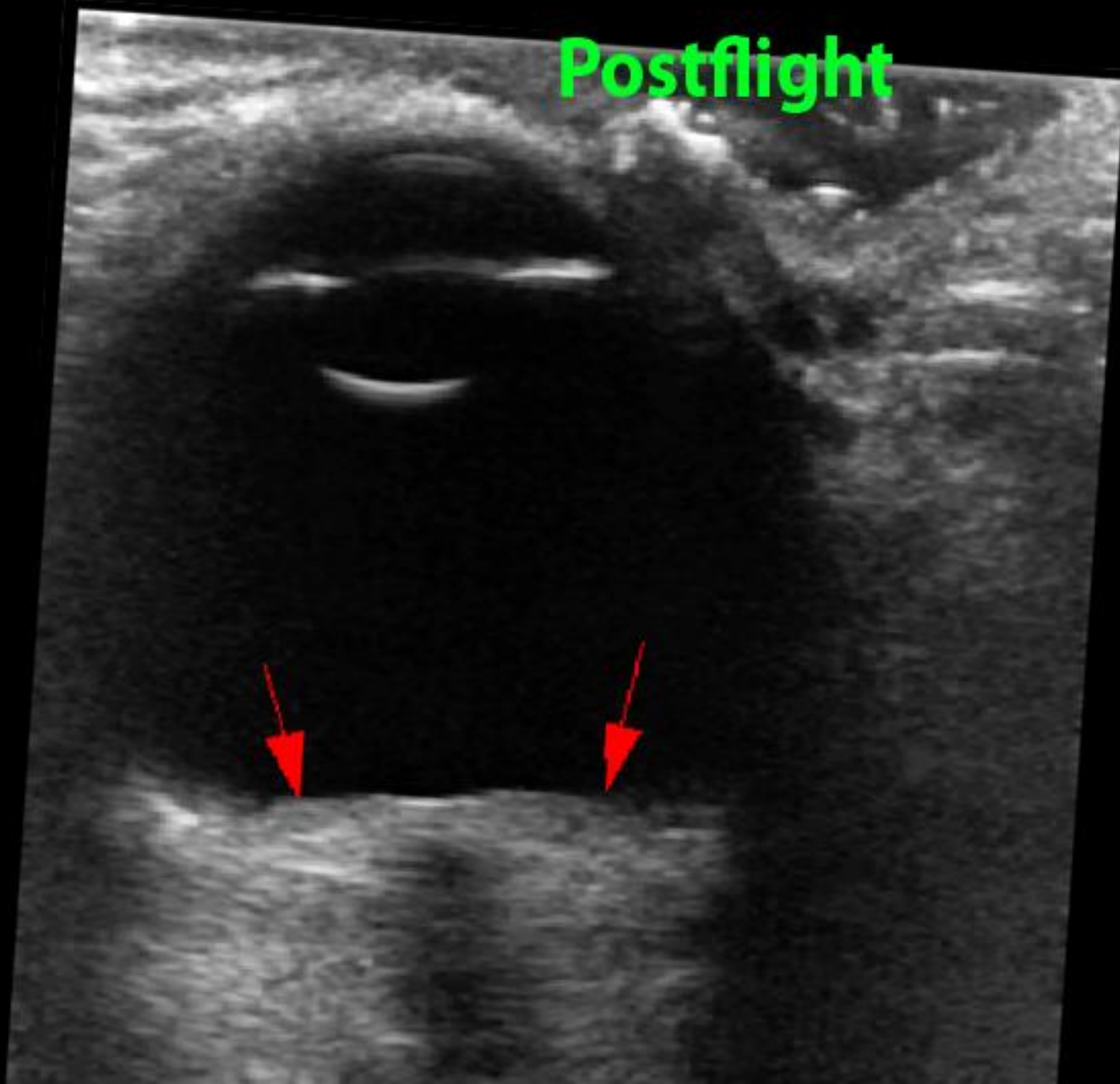
ATL

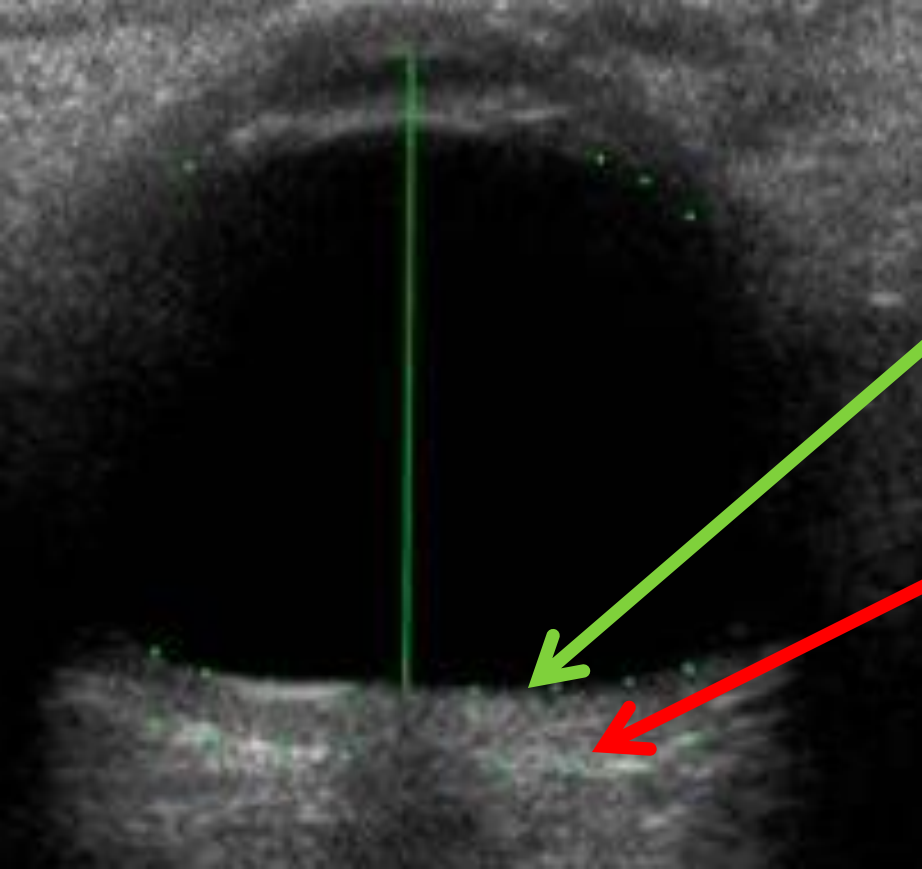
Preflight

Postflight



Postflight

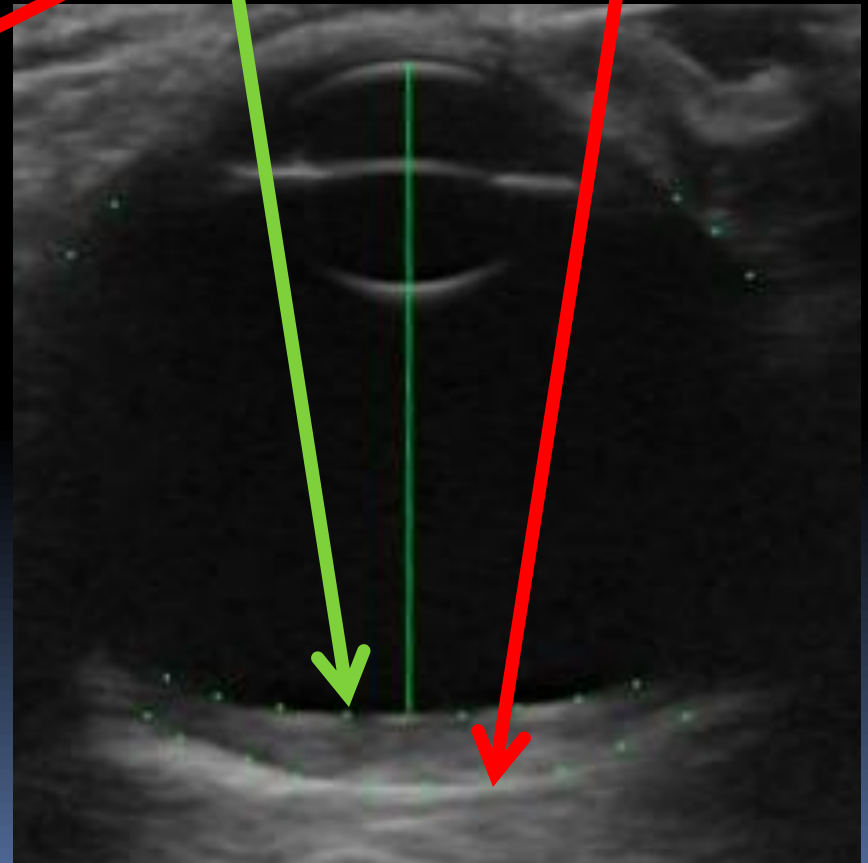




Posterior Pole
Thickening

Retina

Posterior Sclera



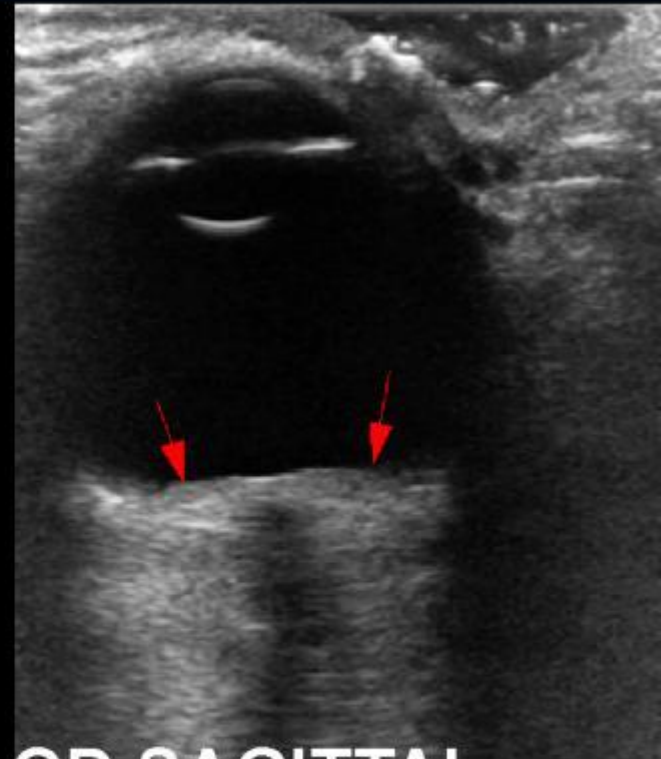
3
B/C5
st Med
ate High
pt:Res

ATL



**OD SAGITTAL
PREFLIGHT**

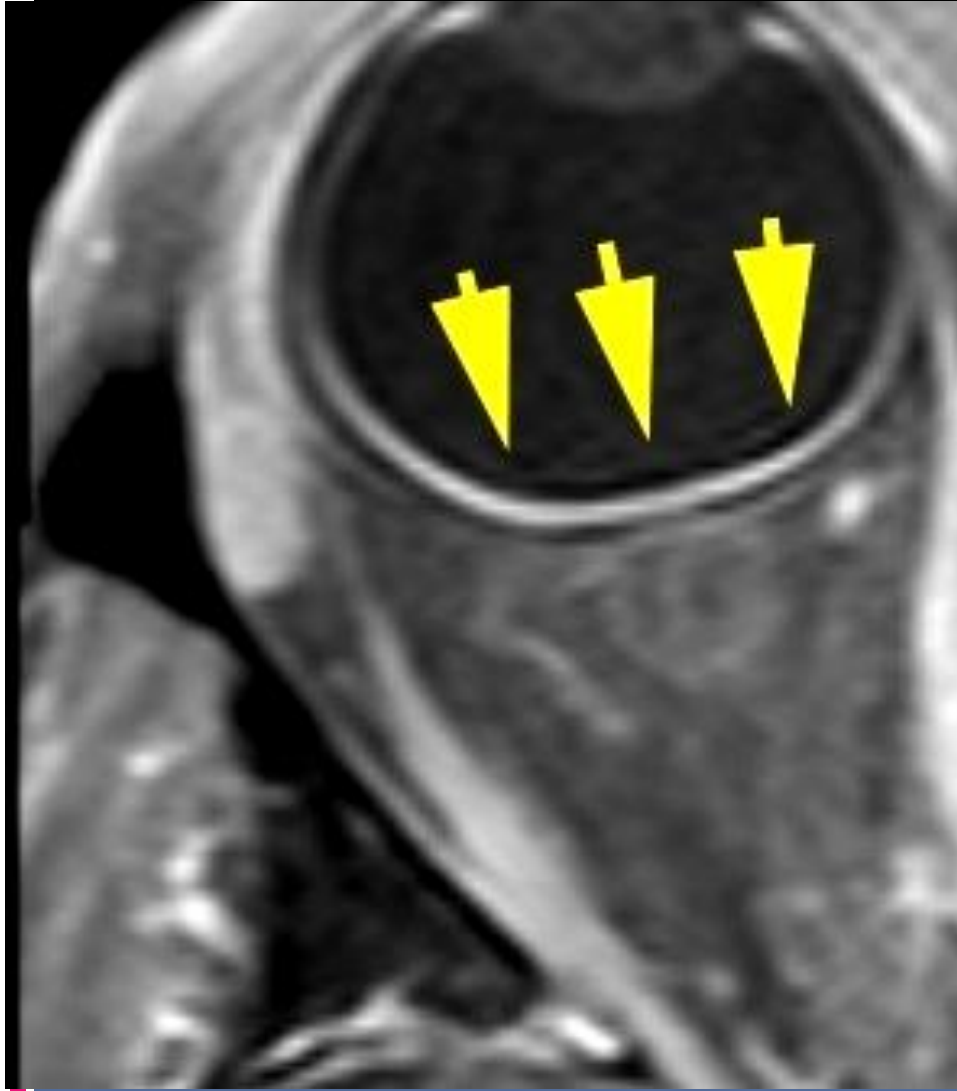
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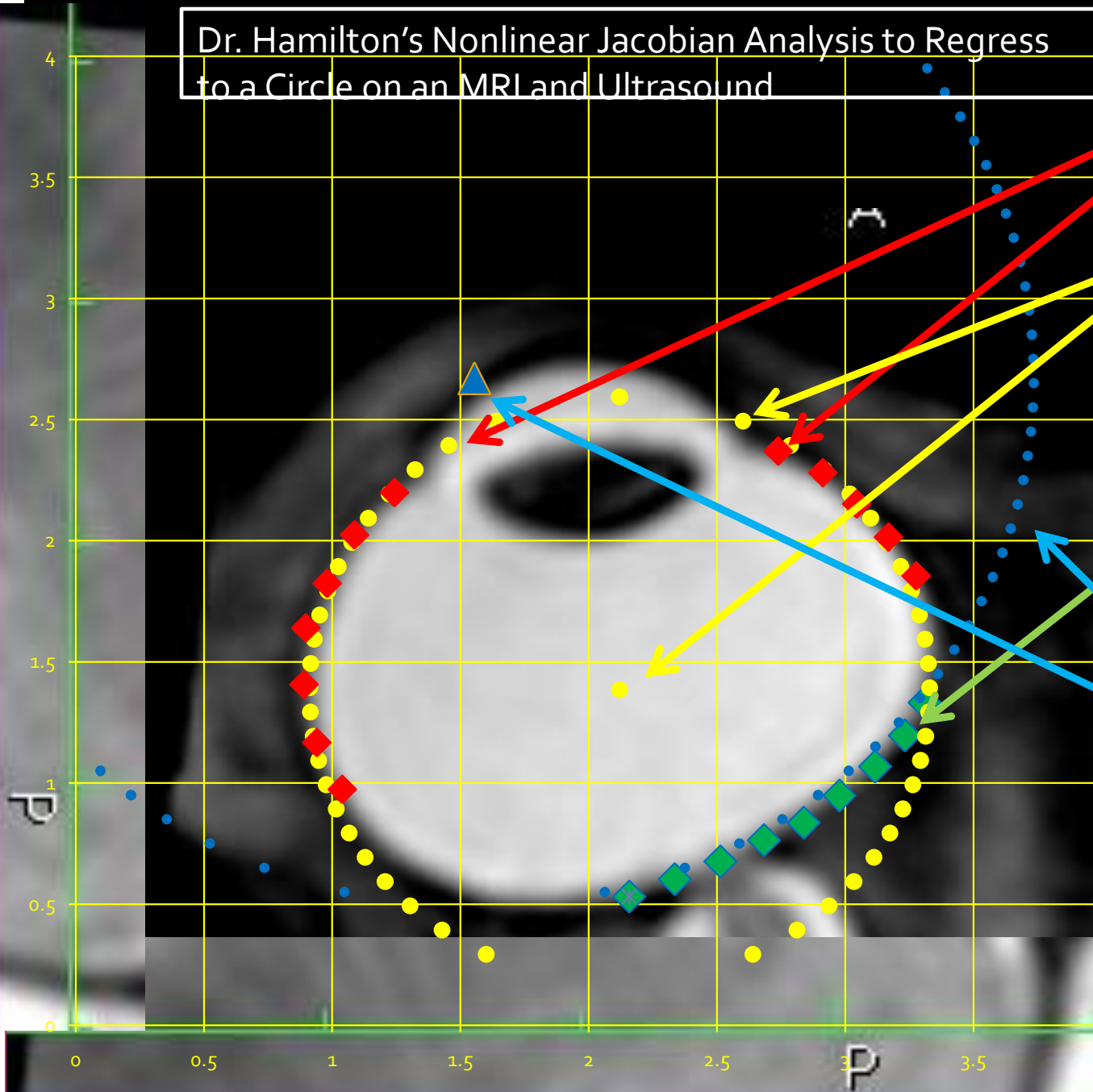
R
2.0

**OD SAGITTAL
OD SAG
POSTFLIGHT**

Globe Flattening



Dr. Hamilton's Nonlinear Jacobian Analysis to Regress to a Circle on an MRI and Ultrasound

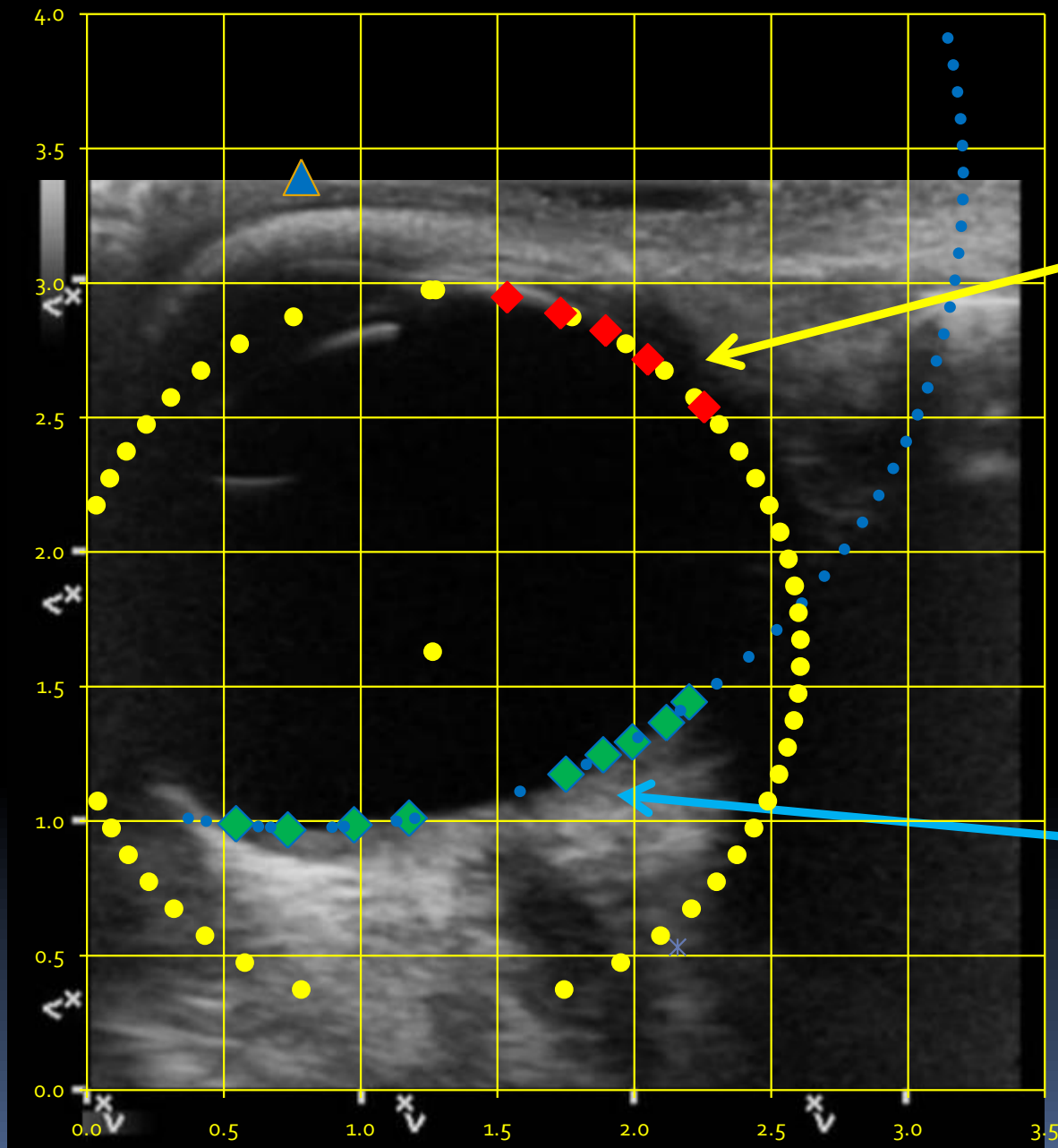


Step 1 - Digitize Anterior Orbit

Step 2 - Calculate Best Circle and Center
Center = (2.12, 1.38)
Radius = 1.20

Step 3 - Digitize Posterior Orbit

Step 4 - Calculate Best Circle and Center
Center = (1.55, 2.67)
Radius = 2.18



Calculate Best Circle
and Center
Center =
 $(1.148, 2.146)$
Radius = 1.131

Calculate Best Circle
and Center
Center = $(-0.737,$
 $19.38)$
Radius = 18.189



HFH-NASA

10/30/08 3:52:13 PM

ADM

N, DANNY

67876

MI 0.24

TIs 0.5

12L-RS

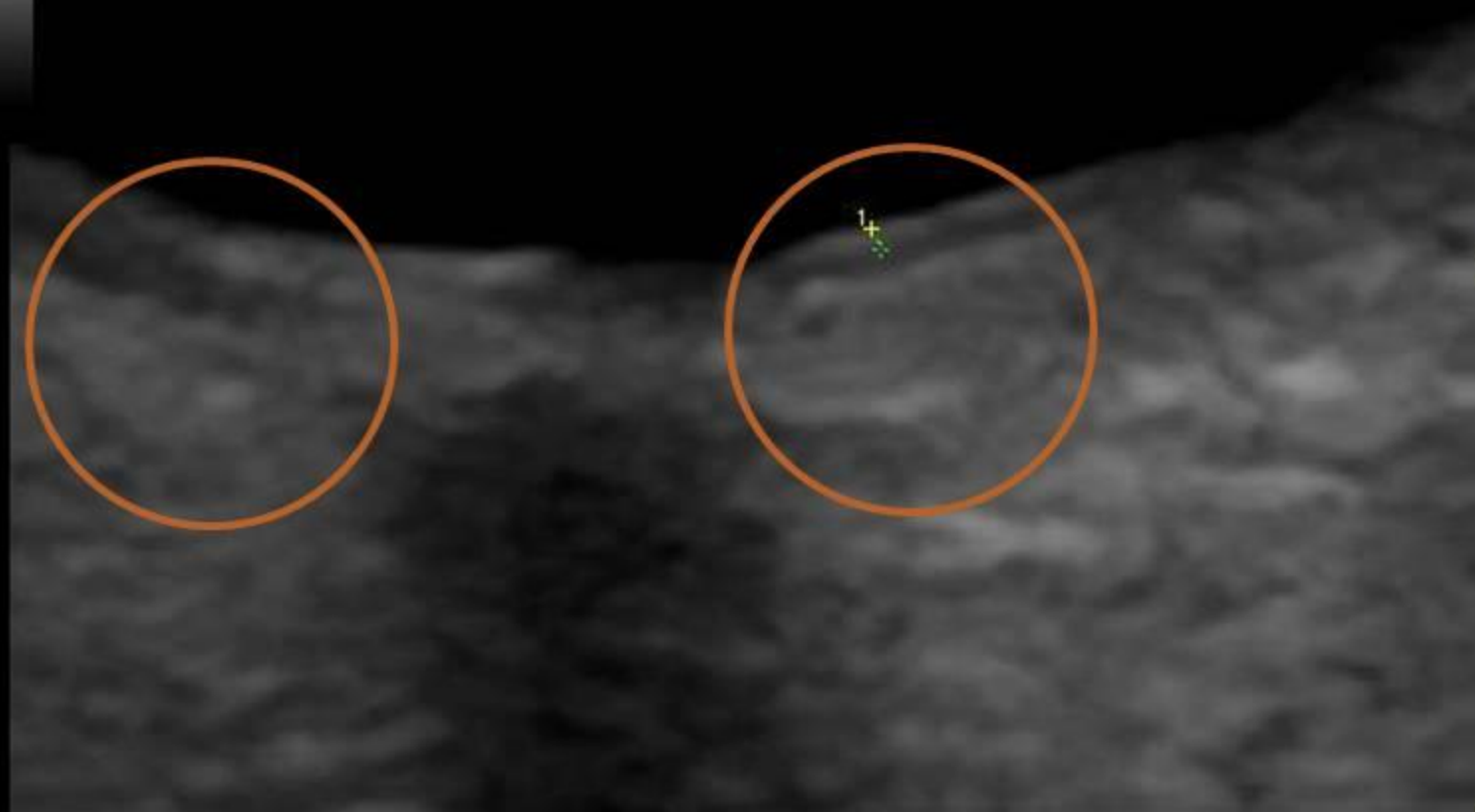
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OPH

GE
L6

Posterior segment

	B	CHI
2.0-	Frq	13.0 MHz
	Gn	38
	E/A	3/3
-	Map	H/0
	D	3.0 cm
	DR	87
-	FR	16 Hz
	AO	80 %

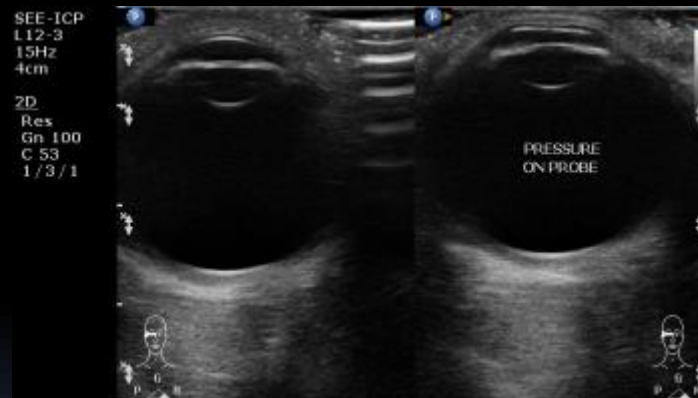


●

✚ L 0.021 cm



Real-time - maneuvers





Results and Conclusion

- MRI and sonography are tomographic methods, however images obtained by the two modalities are based on different physical phenomena and use different acquisition principles.
 - Consideration of the images acquired by these two modalities allows cross-validating findings related to the volume and fluid content of the ON subarachnoid space, shape of the globe, and other anatomical features of the orbit.
 - Each of the imaging modalities also has unique advantages, making them complementary techniques.
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